

## **Technical Guidance for NPS Geologic Resources GPRA Goal**

**Mission Goal Ib : The National Park Service contributes to knowledge about natural and cultural resources and associated values; management decisions about resources and visitors are based on adequate scholarly and scientific information.**

The National Park Service has fundamental information needs for making decisions about managing natural and cultural resources within the national park system. The National Park Service also contributes to scholarly and scientific research. To meet this goal, parks must routinely use scholarly and scientific research and consultation with park-associated communities. Goals that research park resources, either in the field or through documentary sources, and goals that link research data to decision making, are supported by this mission goal.

The following long-term goals relate directly to the knowledge gained about resources and represent the National Park Service's effort to understand the natural and cultural resources within the national park system.

### **Long-term Goals to be Achieved by September 30, 2004:**

**Ib4. Geological Resources--Geological processes in 53 parks [20% of 265 parks] are inventoried and human influence that affect those processes are identified.**

**This goal represents a first step in complying with the National Parks Omnibus Management Act of 1998 (P.L. 105-391, §204) which states, "The Secretary shall undertake a program of inventory and monitoring of National Park System resources to ... provide information on the long-term trends in the condition of National Park System resources."**

Rates of geologic change are key environmental indicators, which collectively, with other vital signs, can be used to gauge the function of healthy ecosystems. It is important that geologic processes be allowed to function in a relatively unaltered state (natural state), to maintain a healthy balance in the ecosystem. This does not imply a static state, but rather a dynamic system of change in physical parameters and biological responses. Understanding the trends or rates of change for geologic processes is a first step to understanding any ecosystem. Factors that can affect rates of geologic change include natural causes, such as weather patterns, and human induced causes, such as dams and jetties. It is the objective of this goal to create a data set that identifies major geologic processes at work in parks and the human induced component of changes in geologic processes.

In order to inventory and evaluate the geologic processes in NPS units, we will use geoindicators (see Appendix C). They are tools for assessing rapid

environmental change. The Commission on Geological Sciences developed geoinicators during a 3-year international project, in the mid-90s, for Environmental Planning. Geoinicators are designed for use in environmental and ecological monitoring, state-of-the-environment reporting, and general assessments of environmental sustainability on local, national and international scales. They help to answer four basic questions.

1. What is happening in the environment? (conditions and trends)
2. Why is it happening? (causes, links between human influences and natural processes)
3. Why is it significant? (ecological, economic and health effects)
4. What are we doing about it? (implications for planning and policy)

This goal will be carried out by careful examination of applicable geoinicators using existing knowledge bases. Members of the geologic community will provide knowledge of geologic processes in parks and the NPS park staff will contribute institutional information about human influences in the park. A series of focus meetings will be held in parks or regions in order to compile and analyze information. It is anticipated that few additional studies will be needed to meet the information requirements of this goal.

Definitions:

**Preserve Park Resources** - The mission goals and long-term goals in Goal Category I are inclusive of the mandate in the NPS Organic Act "...to conserve the scenery and the natural and historic objects and the wild life therein...". Subsequent legislation reinforced and expanded this mission. All NPS goals that deal with resource preservation in parks and the acquisition of knowledge from and about the resources to meet this mandate are appropriate to this category.

**Geological Resources** - Geologic Resources consist of the materials of the Earth, the processes that act on those materials and the resultant features, the chemistry and composition of its constituent materials, the products formed, and the history of the planet and its life forms since its origin. This includes minerals, rocks, fossils, cave and karst systems, coastlines, glaciers, volcanoes, faults, landforms, landslides, structures, fluvial systems, sediments, soils, stratigraphic relations, etc., and the processes forming or altering such geologic features and products.

**Geological Processes** – The natural physical and chemical forces that act within natural systems, as well as upon human developments, across a broad spectrum of space and time. Such processes include, but are not limited to, erosion and sedimentation, glaciation, karstic processes, shoreline development, and seismic and volcanic activity.

**Geoindicators** – They are measures (magnitudes, frequencies, rates, and trends) of geological processes and phenomena occurring at or near the Earth's surface and subject to changes that are significant in understanding environmental change over periods of 100 years or less. They measure both catastrophic events and those that are more gradual, but evident within a human lifespan. Geoindicators can be used to monitor and assess changes in fluvial, coastal, desert, mountain and other terrestrial areas. They can also be used through paleoenvironmental research to unravel trends over the past few centuries and longer, thus providing important baselines against which human-induced and natural stresses can be better understood (See appendix A).

**Inventory** – An itemized list such as a survey of natural resources.

**Human Influences** – (a) Relating to or resulting from the effects of human beings on nature, (b) where human activities alter naturally occurring soil-geomorphic conditions and cause changes in those conditions or the processes acting upon them that would have not occurred otherwise, (c) these should include cover any direct or indirect human related activity inside of the park and outside of the park that could reasonably be expected to impact geologic processes in the park. Examples include but are not limited to air pollution, grazing, mining, roads, construction, visitor use, fire, surface water diversions, ground water pumping, vegetation changes, and others.

**Geology** – See Appendix B

**265 Natural Resource Parks** – See Appendix C

**Performance Indicator:** The number of data sets. For the purpose of this goal a data set consists of geologic processes affected by human influences (GPAHI). There are two components for the data set, (1) an inventory of the geologic processes in a park and (2) an evaluation human influences in the park. An overlay of these two pieces of information creates a unique “data set.”

**Who Reports:** Parks do not report to this goal. Parks acquiring data sets with their own base funding or acquiring other natural and historical resource information or research should report their accomplishments to park-specific goal Ib04.

This goal only deals with the GPAHI data set, not the twelve basic inventories funded by the Inventory and Monitoring Program. For this reason, the Associate Director for Natural Resource Stewardship and Science will consolidate Servicewide information and report on the status of this goal.

**What Gets Reported:** The number of completed data sets for each natural resource park unit (see appendix B for a list of the 265 natural resource parks). A completed data set includes both the park geologic process inventory and an evaluation of

the geologic processes affected by human activity, either inside or outside of the park. Both of these conditions must be met in order for the data set to be considered completed for a given park. The Natural Resource Stewardship and Science Directorate will provide Servicewide baseline information and past performance data.

**Guidance for Ib04:** Parks should report all efforts spent in research, monitoring and development of resource management information on GPAHI. Parks and other field operations will set targets for effort (dollars and FTE) and performance (number of data sets, research reports, monitoring results, etc.).

**Unit Measure:** Number of GPAHI data sets.

**Baseline:** The total number of outstanding data sets identified in 1999 is 265 (all of the natural resource parks).

**Performance Target:** The projected cumulative number of GPAHI data sets that will be collected by the end of a particular fiscal year.

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**Servicewide Annual Goals:**

Ib4.FY 2000 Servicewide Annual Goal: By September 30, 2000, acquire or develop 5 of the 265 outstanding GPAHI data sets identified in 1999 of basic natural resource inventories for all parks. During the first year, Geologic Resources Division staff and field office staff will meet with scientist in the geologic community to develop a strategy, determine the target NPS units and devise an action plan.

Ib4.FY 2001 Servicewide Annual Goal: By September 30, 2001, acquire or develop 12 of the 265 outstanding GPAHI data sets identified in 1999.

Ib4.FY 2002 Servicewide Annual Goal: By September 30, 2002, acquire or develop 12 of the 265 outstanding GPAHI data sets identified in 1999.

Ib4.FY 2003 Servicewide Annual Goal: By September 30, 2003, acquire or develop 12 of the 265 outstanding GPAHI data sets identified in 1999.

Ib4.FY 2004 Servicewide Annual Goal: By September 30, 2004, acquire or develop 12 of the 265 outstanding GPAHI data sets identified in 1999.

## Appendix A. Geoindicators.

Listed here are 27 earth system processes and phenomena that are liable to change in less than a century in magnitude, direction, or rate to an extent that may be significant for environmental sustainability and ecological health. Geoindicators have been developed as tools to assist in integrated assessments of natural environments and ecosystems, as well as for state-of-the-environment reporting. As descriptors of common earth processes that operate in one terrestrial setting or another, Geoindicators represent collectively a new kind of landscape metric, one that concentrates on the non-living components of the lithosphere, pedosphere, hydrosphere, and their interactions with the atmosphere and biosphere (including humans).

1. Coral chemistry and growth patterns
2. Desert surface crusts and fissures
3. Dune formation and reactivation
4. Dust storm magnitude, duration and frequency
5. Frozen ground activity
6. Glacier fluctuations
7. Groundwater quality
8. Groundwater chemistry in the unsaturated zone
9. Groundwater level
10. Karst activity
11. Lake levels and salinity
12. Relative sea level
13. Sediment sequence and composition
14. Seismicity
15. Shoreline position
16. Slope failure (landslides)
17. Soil and sediment erosion
18. Soil quality
19. Streamflow
20. Stream channel morphology
21. Stream sediment storage and load
22. Subsurface temperature regime
23. Surface displacement
24. Surface water quality
25. Volcanic unrest
26. Wetlands extent, structure, and hydrology
27. Wind erosion

Note: There is flexibility to tailor these indicators to fit specific situations in individual NPS units. Not all 27 will be found in each park unit. There are additional Geoindicators that could be added to a park specific list.

The geoindicators checklist has been developed by the International Union of Geological Sciences through its Commission on Geological Sciences for Environmental Planning.

The Geonicators Working Group is chaired by Dr. Anthony Berger. The checklist tool and supporting text is extracted from a new monograph (Berger, A. R. & W. J. Iams 1996. Geoindicators: Assessing Rapid Environmental Changes in Earth Systems.

## Appendix B. Geology Definition.

Geology, as Defined in the Academic Press Dictionary of Science and technology:

To study the earth is to immerse oneself in the duality of history and process. This planet as an astronomical body is ancient, 4.6 billion years old, yet rocks of all ages, from a day-old lava flow to an almost 4-billion-year-old metamorphic rock, can be found in complex structural and stratigraphic arrays on the continents and sea floor. And the earth is being remade today, as it has been all through the history of the planet, by the eruptions of volcanoes, the uplifting of new mountain chains, the erosion of the land by rivers, wind, and ice, and the deposition of sediments in the sea. The constant reworking of the surface of the planet is a reflection of the dynamics of ponderous convective motions of the interior. Geology is thus the study of observable processes operating on earth today, their deeper causes, and the application of that knowledge to the reconstruction of earth history.

In the 200-year modern history of the science, geology has been transformed from its earlier primary task -- the field exploration and mapping of geological formations on the continents -- to a much more diverse view of the earth. Early in its development, geology became inextricably bound to paleobiology, the history of life on earth, and we have come to understand how organic evolution has profoundly affected the surface of the earth. Geology today is closely tied to geochemistry and geophysics. It now includes the geology of the sea floor as well as the continents. Geologists now study not only the solid earth, but also its interactions with the atmosphere and the oceans.

Using knowledge of modern processes we are able to reinterpret the planet's history, from its past plate tectonic movements and continental drift to the composition of ancient atmospheres and the shapes and currents of ancient oceans. From the study of the past, such as the history of recent continental glaciation, we can infer the longer-term planetary processes that have shifted earth from warm to cold climates. The present is not only the key to the past; the past helps us understand the present.

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Appendix C. List of Natural Resource Parks.

Abraham Lincoln  
Birthplace NHS  
Acadia NP  
Agate Fossil Beds NM  
Alagnak Wild River  
Alibates Flint Quarries  
NM  
Allegheny Portage  
Railroad NHS  
American Memorial  
Park  
Amistad NRA  
Aniakchak NM & PRES  
Antietam NB  
Apostle Islands NL  
Appomattox Court  
House NHP  
Arches NP  
Arkansas Post NM  
Assateague Island NS  
Aztec Ruins NM  
Badlands NP  
Bandelier NM  
Bent's Old Fort NHS  
Bering Land Bridge N  
PRES  
Big Bend NP  
Big Cypress N PRES  
Big Hole NB  
Big South Fork NR &  
RA  
Big Thicket N PRES  
Bighorn Canyon NRA  
Biscayne NP  
Black Canyon of the  
Gunnison NM  
Blue Ridge PKWY  
Bluestone NSR  
Booker T. Washington  
NM  
Boston Harbor ?  
Bryce Canyon NP  
Buck Island Reef NM

Buffalo NR  
Cabrillo NM  
Canaveral NS  
Canyon de Chelly NM  
Canyonlands NP  
Cape Cod NS  
Cape Hatteras NS  
Cape Krusenstern NM  
Cape Lookout NS  
Capitol Reef NP  
Capulin Volcano NM  
Carl Sandburg Home  
NHS  
Carlsbad Caverns  
National Park  
Casa Grande Ruins NM  
Castillo de San Marcos  
NM  
Catoctin Mountain Park  
Cedar Breaks NM  
Chaco Culture NHP  
Channel Islands NP  
Chattahoochee River  
NRA  
Chesapeake & Ohio  
Canal NHP  
Chickamauga &  
Chattanooga NMP  
Chickasaw NRA  
Chiricahua NM  
City of Rocks N RES  
Colonial NHP  
Colorado NM  
Congaree Swamp NM  
Coronado NM  
Coulee Dam NRA  
Cowpens NB  
Crater Lake NP  
Craters of the Moon  
NHP  
Cumberland Gap NHP  
Cumberland Island NS  
Curecanti NRA

Cuyahoga Valley NRA  
Death Valley NP  
Denali NP & PRES  
Devils Postpile NM  
Devils Tower NM  
DEWA Land Resources  
Project Office  
Dinosaur NM  
Dry Tortugas NP  
Ebey's Landing NHR  
Effigy Mounds NM  
Eisenhower NHS  
El Malpais NM  
El Morro NM  
Everglades NP  
Fire Island NS  
Florissant Fossil Beds  
NM  
Fort Bowie NHS  
Fort Caroline NM  
Fort Clatsop NM  
Fort Davis NHS  
Fort Donelson NB  
Fort Frederica NM  
Fort Laramie NHS  
Fort Larned NHS  
Fort Matanzas NM  
Fort Necessity NB  
Fort Pulaski NM  
Fort Scott NHS  
Fort Sumter NM  
Fort Union NM  
Fort Union Trading Post  
NHS  
Fort Vancouver NHS  
Fossil Butte NM  
Fredericksburg &  
Spotsylvania NMP  
Friendship Hill NHS  
Gates of the Arctic NP  
& PRES  
Gateway NRA  
Gauley River NRA



George Washington  
Birthplace NM  
George Washington  
Carver NM  
George Washington  
Memorial PKWY  
Gettysburg NMP  
Gila Cliff Dwellings  
NM  
Glacier Bay NP & PRES  
Glacier NP  
Glen Canyon NRA  
Golden Gate NRA  
Golden Spike NHS  
Grand Canyon NP  
Grand Portage NM  
Grand Teton NP  
Grant-Kohrs Ranch  
NHS  
Great Basin NP  
Great Sand Dunes NM  
Great Smoky Mountain  
NP  
Greenbelt Park  
Guadalupe Mountains  
NP  
Guilford Courthouse  
NMP  
Gulf Islands NS  
Hagerman Fossil Beds  
NM  
Haleakala NP  
Harpers Ferry NHP  
Hawaii Volcanoes NP  
Home of Franklin D  
Roosevelt NHS  
Homestead NM of  
America  
Hopewell Culture NHP  
Hopewell Furnace NHS  
Horseshoe Bend NMP  
Hot Springs NP  
Hovenweep NM  
Hubbell Trading Post  
NHS  
Indiana Dunes NL

Isle Royale NP  
Jean Lafitte NHP &  
PRES  
Jewel Cave NM  
John Day Fossil Beds  
NM  
John Muir NHS  
Johnstown Flood N  
MEM  
Joshua Tree NP  
Kalaupapa NHP  
Kaloko-Honokohau  
NHP  
Katmai NP & PRES  
Kenai Fjords NP  
Kennesaw Mountain  
NBP  
Kings Mountain NMP  
Klondike Gold Rush  
NHP  
Knife River Indian  
Village NHS  
Kobuk Valley NP  
Lake Clark NP & PRES  
Lake Mead NRA  
Lake Meredith NRA  
Lassen Volcanic NP  
Lava Beds NM  
Lincoln Boyhood NM  
Little Bighorn  
Battlefield NM  
Little River Canyon NP  
Lyndon B. Johnson  
NHP  
Mammoth Cave NP  
Manassas NBP  
Manzanar NHS  
Marsh-Billings NHP  
Mesa Verde NP  
Minute Man NHP  
Mississippi NRRA  
Mojave N PRES  
Monocacy National  
Battlefield  
Montezuma Castle NM  
Moores Creek NB

Morristown NHP  
Mount Rainier NP  
Mount Rushmore N  
MEM  
Muir Woods NM  
Natchez Trace Parkway  
National Capital Parks-  
East  
National Park of  
American Samoa  
Natural Bridges NM  
Navajo NM  
New River Gorge NR  
Nez Perce NHP  
Ninety Six NHS  
Niobrara/Missouri NR  
Noatak N PRES  
North Cascades NP  
Obed WSR  
Ocmulgee NM  
Olympic NP  
Oregon Caves NM  
Organ Pipe Cactus NM  
Ozark NSR  
Padre Island NS  
Palo Alto Battlefield  
NHS  
Pea Ridge NMP  
Pecos NHP  
Petersburg NB  
Petrified Forest NP  
Petroglyph NM  
Pictured Rocks NL  
Pinnacles NM  
Pipe Spring NM  
Pipestone NM  
Point Reyes NS  
Prince William Forest  
Park  
Pu'uhonua o Honaunau  
NHP  
Puukohola Heiau NHS  
Rainbow Bridge NM  
Redwood NP  
Richmond NBP  
Rock Creek Park

Rocky Mountain NP  
Russell Cave NM  
Sagamore Hill NHS  
Saguaro NP  
Saint Croix/Lower St.  
Croix NSR  
Saint-Gaudens NHS  
Salinas Pueblo Missions  
NM  
San Antonio Missions  
NHP  
San Juan Island NHP  
Santa Monica  
Mountains NRA  
Saratoga NHP  
Saugus Ironworks NHS  
Scotts Bluff NM  
Sequoia & Kings  
Canyon NP  
Shenandoah NP

Shiloh NMP  
Sitka NHP  
Sleeping Bear Dunes  
NL  
Stones River NB  
Sunset Crater Volcano  
NM  
Tallgrass Prairie N  
PRES  
Theodore Roosevelt NP  
Thomas Stone NHS  
Timpanogos Cave NM  
Timucuan Ecological &  
Hist Preserve  
Tonto NM  
Tuzigoot NM  
Upper Delaware Scenic  
and Rec. River  
Valley Forge NHP  
Vicksburg NMP

Virgin Islands NP  
Voyageurs NP  
Walnut Canyon NM  
War in the Pacific NHP  
Weir Farm NHS  
Whiskeytown-Shasta-  
Trinity NRA  
White Sands NM  
Whitman Mission NHS  
Wilson's Creek NB  
Wind Cave NP  
Wrangell-St Elias NP &  
PRES  
Wupatki NM  
Yellowstone NP  
Yosemite NP  
Yucca House NM  
Yukon-Charley Rivers  
N PRES  
Zion NP